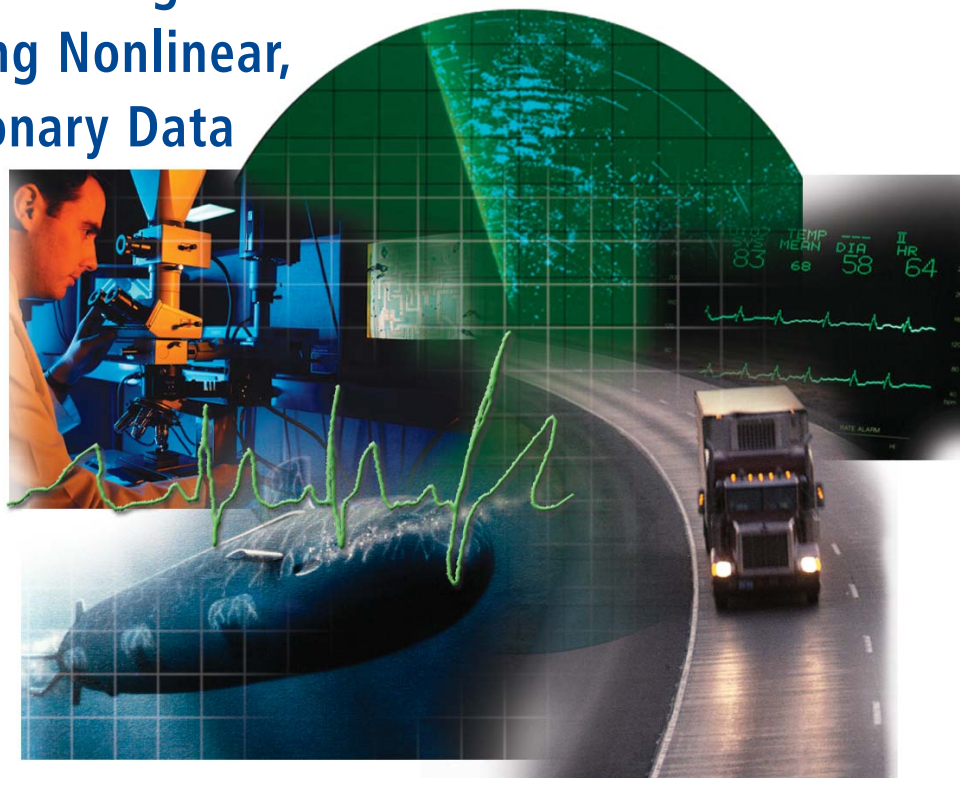
Superior Algorithms for Analyzing Nonlinear, Nonstationary Data



NASA offers companies the opportunity to license the Hilbert-Huang transformation technology for use in commercial applications.

Developed at NASA Goddard Space Flight Center, the Hilbert-Huang transformation (HHT) technology is a highly efficient, adaptive, and user-friendly set of algorithms capable of analyzing time-varying processes. Designed specifically for nonlinear and nonstationary signals, HHT can be used to analyze data in a wide variety of applications. The algorithms also provide increased accuracy when used to analyze linear and stationary signals.

Benefits

- ***Precision:*** More precise analysis of signal data and sharper filter performance than provided by Fourier-based methods
- ***Flexibility:*** Capable of processing both linear and nonlinear and stationary and nonstationary signals with great accuracy
- ***Accuracy:*** Preserves the intrinsic properties of the data rather than analyzing an "interpretation" of the data, as in Fourier methods
- ***Easy implementation:*** Easy and inexpensive to implement in software or hardware
- ***Real time operation:*** Operates and yields physically meaningful results in real time
- ***Multifunctionality:*** Generates analytic functions for a data set where other methods fail; generates previously unattainable data for aiding in diagnosis of abnormal conditions; and provides new, quantitative measurements that enhance understanding of underlying physiological phenomena

National Aeronautics and Space Administration

The Technology

This new tool was specifically designed for analysis of nonlinear, nonstationary data. The HHT algorithms accurately analyze physical signals via the following steps:

1. Instantaneous frequencies are calculated based on the Empirical Mode Decomposition method when intrinsic mode functions (IMFs) are generated for complex data.
2. A Hilbert transform converts the local energy and instantaneous frequency derived from the IMFs to a full energy-frequency-time distribution of the data (i.e., a Hilbert spectrum).
3. The physical signal is filtered by reconstruction from selected IMFs.
4. A curve can be fitted to the filtered signal (curve fitting might not have been possible with the original, unfiltered signal).

Winner of the Federal Laboratory Consortium (FLC) award for excellence in technology transfer, this technology is a highly efficient, adaptive, and user-friendly general computational method. Compared to current transform methods and technologies, HHT offers improved accuracy and yields results with more physical meaning than existing analysis tools that tend to obscure or discard valuable information. HHT can be used to:

- Analyze and correct linear, nonlinear, stationary, and nonstationary data
- Analyze data to understand underlying phenomena
- Fuse data from multi-sensors
- Aid in signal recognition
- Monitor, detect, and diagnose abnormal conditions
- Predict failure
- Reduce noise and vibration
- Improve signal clarity
- Identify outliers
- Derive an analytic function to represent a phenomenon
- Facilitate numerical stimulation

Applications

Medical: Sensors, devices/instruments, imaging, and design

Acoustics, noise, and vibration: Highway noise, submarine design, machine vibration analysis, speech/sound analysis, and speaker/sound recognition

Environmental: Surface temperature data, radiometer data, connecting environmental changes to phenomena, sonar, radar, lidar, and seismology

Industrial: Machine monitoring and failure prediction, electrical circuits, heat conduction and convection, and nondestructive testing

Fluids: Numerical simulation of fluid flow

Structures: Nondestructive testing and shock loading

Business/Finance: Economic data and market data

Partnering Opportunities:

This technology is part of NASA's technology transfer program. NASA invites companies to consider licensing the Hilbert-Huang transformation technology for use in commercial applications.

For More Information

If you are interested in more information, or want to pursue transfer and commercialization of this technology, please contact:

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http://techtransfer.gsfc.nasa.gov/hht

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